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## Tech Notes



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# Adding Dc Offset to an Amplifier

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Are dc offset correction and gain accuracy concerns for you? There are several frequently used methods of adding dc offset to an amplifier and three methods will be compared and contrasted here:

1. Resistor using a non-inverting amplifier,
2. Resistor using an inverting amplifier,
3. Transistor using a non-inverting amplifier.

Two additional dc offset techniques will be noted.

The most common dc correction circuit uses a non-inverting amplifier and adds a dc voltage to the inverting terminal (see Fig. 1.)

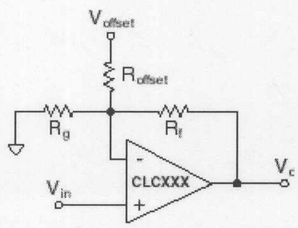


Figure 1: Dc Offset Method I: Non-inverting Configuration

The solution is simple and definitely adds a dc offset but this topology is not a simple solution if gain accuracy is also a major concern. The additional resistor, $R_{offset}$, is now a part of the gain equation. The transfer function of the circuit in Fig. 1 is:

$$V_o = V_{in}\left(1 + \frac{R_f}{R_g} + \frac{R_f}{R_{offset}}\right) - \frac{V_{offset} R_f}{R_{offset}}$$

and the additional resistor, $R_{offset}$, must be considered when calculating the gain. Gain accuracy is now also dependent on the tolerance of 3 resistors instead of 2.

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An alternative solution is to simply change to an inverting configuration (see Fig. 2.)

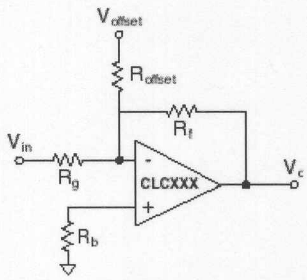


Figure 2: Dc Offset Method II: Inverting Configuration

This configuration provides a dc offset without affecting the gain; the transfer function for the circuit in Fig. 2 is:

$$V_o = -V_{in}\left(\frac{R_f}{R_g}\right) - \frac{V_{CC} R_f}{R_{offset}}$$

the additional resistor, $R_{offset}$, affects the amount of offset added to the amplifier, not the original gain. If a simple 180° phase shift is tolerable in the design, then use this method of adding dc offset. The lack of effect on gain is not the only advantage to operating in an inverting configuration, in most cases amplifiers operate faster in an inverting configuration and you reduce the chances of saturating the input.

A third method of adding dc offset to an amplifier (illustrated in Fig. 3) uses a non-inverting amplifier and a transistor to add offset to the inverting node:

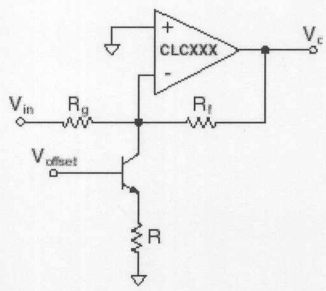


Figure 3: Dc Offset Method III: Inverting Configuration with Transistor

This third method uses a transistor to add current into the inverting node. The transistor's collector is a high impedance and, to a first measure, does not affect the amplifier's loop gain. The resulting transfer function is:

$$V_o = -V_{in}\left(\frac{R_f}{R_g}\right) + \frac{R_f(V_{offset} - 0.7)}{R}$$

Two additional methods (3 and 4) are also commonly used techniques of adding offset to an amplifier. Method 3 employs a non-inverting amplifier and a resistor that adds offset to the non-inverting terminal. Fig. 4 illustrates this technique:

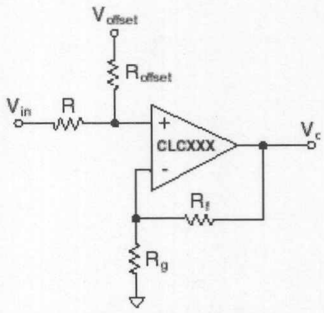


Figure 4: Dc Offset Method IV

$$V_o = \left(\frac{V_{in}}{1+\frac{R}{R_{offset}}}\right)\left(1+\frac{R_f}{R_g}\right) + \left(\frac{V_{offset}}{1+\frac{R_{offset}}{R}}\right)\left(1+\frac{R_f}{R_g}\right)$$

Method 5 uses an inverting amplifier and a resistor that adds offset to the non-inverting terminal and Fig. 5 shows this technique:

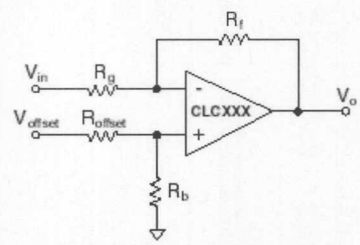


Figure 5: Dc Offset Method V

$$V_o = -V_{in}\frac{R_f}{R_g} + \frac{V_{offset}R_b}{R_g}\left(\frac{R_f+R_g}{R_b+R_{offset}}\right)$$

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